SOUND PERFORMANCE LAB

Manual

Machine Head

Model 9737

Digital Tape Saturation Processor

SOUND PERFORMANCE LAB

MACHINE HEAD
MODEL 9737

Manual

by Hermann Gier
Version 1.3 – 1/1999

The information in this document has been carefully verified and is assumed to be correct. However Sound Performance Laboratory (SPL) reserves the right to modify the product described in this manual at any time. Changes without notice. This document is the property of SPL and may not be copied or reproduced in any manner, in part or full without the authorization of SPL.

Limitations of Liability:
In no event will SPL be liable for any damages, including loss of data, lost profits, cost of cover or other special, incidental, consequential or indirect damages arising from the use of the unit, however caused and on any theory of liability. This limitation will apply even if SPL or an authorized dealer has been advised of the possibility of such damage.

SPL electronics GmbH
P.O. Box 12 27
D- 41368 Niederkruechten, Germany

Phone: +49 - 21 63 / 9 83 40
Fax: +49 - 21 63 / 98 34 20

eMail: info@spl-electronics.com

www.spl-electronics.com

© 1999 SPL electronics GmbH. All Rights Reserved.

Contents

Foreword	3
Thanks	3
Introduction	4
Operation Safety	5
Connections	6
Installing Updates	6
Quick Start	7
Analogue Tape Recording Signal Flow	7
Control Elements	8
ACTIVE	8
INPUT GAIN	8
DRIVE	8
HF-ADJUST	9
OUTPUT GAIN	10
HIGH TAPE SPEED	10
LC-DISPLAY	10
LED CHAINS	10
PRESETS	11
INFO (HARDWARE DIALOGUE)	11
Specifications	15
Warranty	16

Foreword

Dear customer,

Thank you for the confidence you have shown towards SPL electronics GmbH by purchasing the SPL MACHINE HEAD. You have decided to use a tool of high performance which sets you in the position to have faster success and a better sound quality in your music productions, pre-masterings and masterings.

As a typical SPL unit the MACHINE HEAD combines exemplary specifications and high manufacturing standard with excellent sound quality to provide you a precious component for studio and mastering purposes. Please read this manual carefully to ensure you have all the information you need to use the MACHINE HEAD.

We wish you every success with the MACHINE HEAD.

Your SOUND PERFORMANCE LAB-Team

Thanks

I would like to start with my thanks to all our staff, who created what is to be described here. Special thanks go to Kai Lukas from Lukas & Hartmann Soundart, Jörg Houpert and Klaus-Peter Webersinke from Spectral Design as well as Harald Obenland from Octum electronics. The importance of their exceptional qualification and talents cannot be overestimated.

Our products are often tested and compared in many publications and by our customers themselfs and constantly valued with best results. I would like to pass on this broad appreciation to those, who deserve it – my excellent colleagues.

Hermann Gier

© SPL electronics GmbH Germany 1997

Introduction

Creating authentic tape saturation effects.

The sound becomes warmer and more powerful, eliminating the harshness of digital recordings.

Precise reproduction of:
- tape saturation effect
- hysteresis effect
- harmonic characteristic
- linear and non linear transmission characteristic

Modified reproduction of:
- level behaviour
- high frequency damping

Not reproduced are:
- cross-talk
- pre or post echos
- noise floor
- motor speed fluctuation

Easy and intuitive operation

The MACHINE HEAD is a creative sound and dynamics processor within SPL´s Digital-Red series.

Concept: The algorithm used by MACHINE HEAD computes authentic tape saturation effects, hitherto unavailable in the digital domain.

The subjective sonic effects are an increase in loudness and a better penetration of the mix at identical peak level. The sound becomes warmer and more powerful, and the process eliminates the harshness usually associated with digital recordings.

MACHINE HEAD is designed for mastering applications. Mixes gain more power, punch and warmth. It is also suited to process single instruments, like electronic or acoustic guitars and basses, drums, loops and samples, as well as complete stereo mixes.

The algorithm used by MACHINE HEAD precisely reproduces the analogue tape saturation effect, including hysteresis effects, the harmonic characteristic and both linear and non-lineare transmission-characteristic (other than level) that occur when recording to analogue tape.

The level behaviour and high frequency damping is reproduced in a modified manner. To achieve the best possible signal to noise ratio, an auto gain cell has been implemented into the algorithm in order to create a processing range for saturation effects for full scale input signals and to deliver full scale output signals afterwords. The intensity of high frequency damping varies from one tape to another, and is therefore fully adjustable one the MACHINE HEAD. It is now also possible to make use of extreme saturation effects without high frequency damping at all.

In fact MACHINE HEAD provides all the benefits of analogue recording without any of the shortfalls – MACHINE HEAD does not reproduce cross-talk, pre or post echoes, noise floor (field noise, modulation noise) and motor speed fluctuation characteristics of analogue tape machines!

Operation: MACHINE HEAD is operated with four controls and one switch function:

INPUT GAIN: Controls the input level of the digital data stream

DRIVE: Controls the drive or recording level of the "virtual analogue tape machine"

HF-ADJUST: Controls the intensity of high frequency boost or damping

OUTPUT GAIN: Controls the output level of the digital data stream

HIGH TAPE SPEED: Switches from normal tape speed (15ips) to high tape speed (30ips).

© SPL electronics GmbH Machine Head

Indicators and meters:

MACHINE HEAD is equipped with PPM displays for input and output levels. The first LED of each input and output meter is a signal (SIG.) LED which illuminates when a compatible digital data stream is present at the inputs. The LEDs are a first indicator to check the data stream. If the LEDs do not illuminate the data stream is interrupted or invalid.

SIGNAL-LEDs to verify data stream

The top LEDs of each input and output meter indicate if a digital clip has occured at the inputs or due to processing within MACHINE HEAD. Clipping that is already present at the inputs will also be shown on the OUTPUT PPM chains.

Clip-LEDs

Input and Output PPM metering

The DRIVE LED chains display the drive or recording level that is sent to the virtual tape. The values shown range from -10 dB to +21 dB.

DRIVE-LED displays recording level

The philosophy behind the digital audio processors is that they are designed to be operated like analogue units; there is only one INFO menu but no multi-function controls. The LCD readout simply shows the current encoder positions and the preset number. The encoders are built without clicks or detents, so they feel like analogue pots. Our DSP platform uses two Motorola 56002 DSPs running at 66 MHz. This enormous computational power guarantees real-time operation where sophisticated DSP algorithms will not be restricted by resource limitations. The general concept is that each digital processor should fulfill only one task, in the most effective way possible, and with a minimum of controls and switches. As much as possible should be automated to promote user-friendly operation – the external controls access only the sonically relevant parameters.

The DSP Platform: Enormous computational power guaranteeing real-time operation

„Analogue" control feeling

User-friendly programmed software

Operation Safety

The housing of the MACHINE HEAD has the standard 19"- EIA format and occupies 1U (44.45 mm) in your rack. When installing the unit in a 19"-rack, the rear side of the unit needs some support, especially in a touring case.

The MACHINE HEAD should not be installed near units which produce strong magnetic fields or extreme heat. Do not install the MACHINE HEAD directly above or below power amplifiers.

Check that the voltage details quoted on the back panel are the same as your local mains electricity supply. Use a minus (-) screwdriver to set the voltage selector to the voltage for the area in which the unit will be used.

Never cover up the ventilation slots on the top of the unit. If, during operation, the sound is interrupted or indicators no longer illuminate, or if abnormal odor or smoke is detected, or if liquids are spilled on the unit, immediately disconnect the power cord plug and contact your dealer.

Only clean your MACHINE HEAD with a soft, lint-free cloth.

Connections

Before connecting the MACHINE HEAD switch the power off at all connected units.

The rear panel provides AES/EBU- and S/P-DIF-inputs and outputs. Any additional channel, status and user-bits are passed through unaltered, and the outputs can be used at the same time if required.

The MACHINE HEAD operates with 24 bit word width. It accepts 16 to 24 bit inputs and will create output signals according to the input resolution.

For synchronisation purposes WORDCLOCK IN and WORDCLOCK THROUGH BNC connectors are fitted with a switchable 75 Ohm termination.

MIDI IN and MIDI THROUGH connectors allow presets to be selected via MIDI program change commands.

For easy upgrade of future software releases, the rear panel offers RS-232 interface for PC and RS-422 interface for MAC.

Installing Updates:

Note: All presets will be lost after installing a new software version!

1. Connect your computer with the MACHINE HEAD via a serial port with a standard Z-modem cable.

   RS-232 for PC and RS-422 for MAC.

2. Open a terminal program like "Hyperterminal" on PC and make the following adjustments:

   Baud rate: 9600; Stop bit: 1; Parity: none; Data bit: 8; Handshake: no; Transfer mode: ZMODEM

3. **Switch on the MACHINE HEAD and depress both PRESET UP and PRESET DOWN until the LC-display says** *"wait for Zmodem download"*.

4. Load the update file into your terminal program and send it to the MACHINE HEAD. The LC-display shows the progress of the download in kB.

5. After successfully installing the new software version the LC-display says *"download valid"*.

6. Switch the MACHINE HEAD **off and on after 4 sec. The new software version number is displayed in the first INFO page (simultaneously depress STORE and APPLY; also refer to CONTROL ELEMENTS No. 9, INFO).**

7. If an error occurred during download the LC-display says *"download failed"*. **The MACHINE HEAD now waits for a new download. Please check all adjustments on your terminal program and try again.** If you are still unsuccessful contact your local dealer.

Quick Start

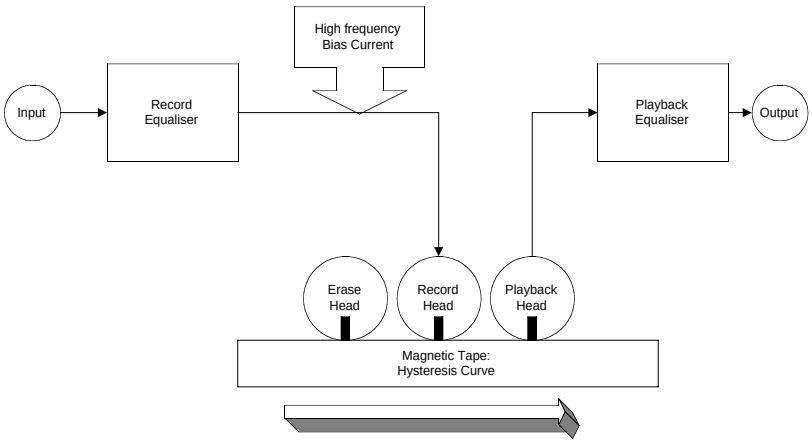
All controls are in the start-off positions:

INPUT GAIN 0, DRIVE 0, HF-ADJUST 0,

OUTPUT GAIN 0, TAPE SPEED 15

1. Press ACTIVE. LED illuminates.
2. Increase the DRIVE-value to saturate the "virtual" tape. Set DRIVE to about 6. If the output level increases, use the OUTPUT GAIN control to compensate for the increase.
3. If more saturation is wanted, it may be necessary to reduce the INPUT GAIN slightly to prevent dipping.
4. Use the HF-ADJUST control to create the typical high frequency damping effect (negative values) or increase the high frequencies and harmonical content (positive values).

Analogue Tape Recording Signal Flow



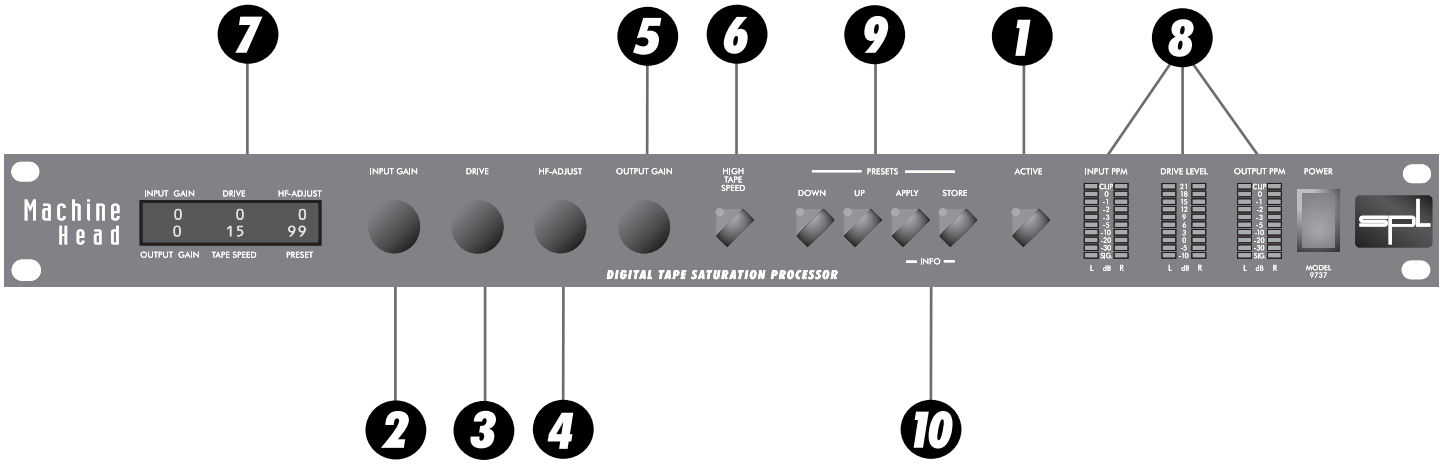
The audio signal that passes the input electronics of an analogue tape machine is first processed by the recording equalizer. The high frequencies are boosted to compensate for the level loss of those frequencies during magnetization and to improve the signal to noise ratio.

A high frequency bias current is afterwards added to the signal to linearize the non linear hysteresis transfer curve of the magnetization.

The recording head converts the current of the input signal into a magnetic field. The field magnetizes the magnetic particles on the passing tape. This process is physically complex and non linear. Hysteresis curves lead to the typical saturation effect and to the effect of short wavelength losses.

The playback head converts the magnetic field of the passing tape back into current and voltage. The playback equalizer has a normed frequency response (e.g. CCIR/NAB) which makes the overall freqency response flat and compensates for the additional boost in the recording equalizer.

Control Elements



Active

1

Relay hard-bypass for AES/EBU input and output

The ACTIVE function switches the MACHINE HEAD on or off. The illuminated LED indicates that the processing has been activated.

The software bypass also compensates for the 5ms time delay between processed and unprocessed signal.

The AES/EBU input and output are equipped with relay-hard-bypass. In the event of a power failure the MACHINE HEAD is automatically switched to hard-bypass (power failure safety) without interrupting the data flow.

Input Gain

2

INPUT GAIN adjusts the input level of the digital data stream . Adjustable values range from -12.0 dB to +12.0 dB in 0.1 dB steps. The value is shown in the LC-display (see 6) and the INPUT PPM meters displays the actual input level after theINPUT GAIN control.

In practise you will start with the INPUT GAIN set to 0 dB. For most applications this is the appropriate setting. If your source material is of ver y low level or not normalized yet, you can use the INPUT GAIN control to drive the source material near full scale. If you are processing full scale material it may be necessary to reduce the input signal by one or two dBs to create new headroom for the processing. Reduce the INPUT GAIN with the proviso of the INPUT-CLIP LEDS (see 8).

Drive

3

Setting the recording level of the 'virtual tape machine'

The DRIVE control is the most important parameter of the MACHINE HEAD. You set the recording level above the normal working level of the analogue tape machine. The adjustable values range from -7 to +14 in 0.2 dB steps and will be shown in the LC-display (see 7). The corresponding recording level is displayed by the DRIVE LEVEL-LED bars (see 8).

The higher the DRIVE the more intense gets the saturation of the tape. While increasing the DRIVE value the output level may increase, too. Compensate for this by reducing the OUTPUT GAIN value (see 5) and monitor the OUTPUT LEVEL meters. The subjectively the perceived loudness will increase more dramatic than the actual PPM value!

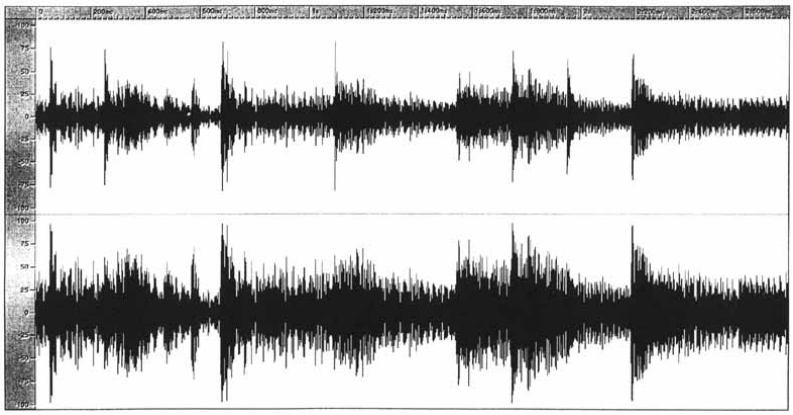
Recommended values are 3 to 8 for the DRIVE-parameter which corresponds with +10 dB to +15 dB for the actual DRIVE LEVEL shown in the LED meter bar.

Practical values for the DRIVE are 3 to 8.

When booting the MACHINE HEAD the default value of the DRIVE parameter will be 0 in the LC-display. If you have "the perfect pitch" you can already hear slight saturation effects. To keep the handling of the MACHINE HEAD as simple as possible, it is necessary to provide a 1:1 level when activating the process for instant comparison between unprocessed and processed signal. Internally the MACHINE HEAD has to create a headroom – especially when processing full scale material – to compute the tape saturation algorithm. With a DRIVE set to 'true 0' you will loose 7dB headroom. As a starting position the DRIVE is therefore set to 0 which is equivalent to +7dB of recording level. Therefore you also have negative values for the DRIVE parameter. A 'true' 1:1 input/output setting is achieved by setting the DRIVE to -7 dB and the INPUTGAIN to +7 dB.

The paragraph besides offers some information on internal signal level management.

The corresponding level is displayed in DRIVE LEVEL PPM meters (see 8).



Above: original signal

Below: processed signal showing increased loudness

Both signals are normalized to 0 dBFs.

4 HF-Adjust

The HF-ADJUST control allows you to control the amount of high frequency damping or boosting. The control range is -6 (max. damping) to +6 (max boost).

Adjusting the high frequency damping effects

The higher you saturate a real tape the more high frequency damping takes place. With the MACHINE HEAD you can set the amount of damping independent of the DRIVE LEVEL. You can either use a strong damping effect with low saturation or the other way around. This freedom is not offered by a real tape machine.

On the other hand you can boost the high frequencies which simulates overemphasized harmonics e. g. due to improper calibration of the tape machine or differences in tape quality.

Output Gain

5

Compensating a level and/or loudness increase due to processing

OUTPUT GAIN varies the output level of the digital data stream. It is variable between -12 dB and +12 dB in 0.1 dB steps.

The adjusted OUTPUT GAIN value is shown in the LC-display (see 7) and in the OUTPUT PPM meter (see 8).

In practice you will start with the OUTPUT GAIN set to 0 dB. In case you have used high DRIVE values you will use the OUTPUT GAIN to compensate for the slight level increase.

You can also use the OUTPUT GAIN control to compensate for the loudness difference between unprocessed and processed signal to judge upon the sonic effect alone. After you have reduced the OUTPUT GAIN until original and processed signal have the same loudness you can readout the loudness increase on the OUTPUT PPM meters compared to the INPUT PPM meters.

Also, if you have chosen a positve setting on the HF-ADJUST control, it may be necessary to reduce the OUTPUT GAIN slightly in order to prevent clipping. Watch the CLIP-LEDS!

You will set a positive OUTPUT GAIN, when there is still headroom left after processing. Always check this on the loudest part of the audio file being processed and watch the CLIP-LEDs.

High Tape Speed

6

Gaining a finer high frequency resolution when selecting HIGH TAPE SPEED.

With the HIGH TAPE SPEED switch you can change the speed of the vitual tape from standard tape speed (15 ips) to high tape speed (30 ips).

When HIGH TAPE SPEED is activated the algorithm simulates the pre-emphasis for high speed recording. The upper mid and high frequencies as well as the harmonical content gain better resolution and finer detail.

Note that the 40 Hz to 70 Hz bass-reduction induced when recording to analog tape at 30 ips is not reproduced!

LC-display

7

The LC-display shows all encoder settings and the number of the preset being used in the last session with the MACHINE HEAD (for details on PRESETS refer to 9).

More information is displayed when activating the INFO pages (see 10). Press STORE and APPLY for 1 sec. to enter the INFO pages.

LED chains

8

The INPUT and OUTPUT LED chains are PPM (peak level) meters with signal and clip indicators. The metering offers 1 dB resoltion for the last 3 dB before 0 dB.

The INPUT PPM meters show the peak level after the INPUT GAIN control (see 2).

The DRIVE LEVEL metering shows the recording level of the "virtual tape machine". The display range is -10 dB to +21 dB. The DRIVE LEVEL ist adjusted with the DIRVE control (see 3).

The OUTPUT PPM meters show the peak level after the OUTPUT GAIN control (see 5).

The first LED in each INPUT and OUTPUT PPM meter is a signal (SIG.) LED to indicate that a valid digital source is connected and detected. This LED helps you to verify the signal flow within a digital processing chain. If one SIG. LED is not illuminating you have a first indication of a faulty digital signal flow.

The last LED of each INPUT and OUTPUT PPM meter is a CLIP LED. The LED illuminates if the digital signal is too hot causing digital distortion.

9 Presets

The MACHINE HEAD allows you to store up to 99 presets, which can be changed by MIDI program change command.

If you want to store a new adjustment, depress STORE for one second. The LED starts to flash indicating that the STORE mode has been activated. The LC-display now shows the values of the presets (including the BOOST function) before the MACHINE HEAD was switched off the last time. Use UP and DOWN to select a new preset number. The status-LED flashes shortly to indicate that the input (depressing UP or DOWN) is accepted. Keeping UP or DOWN depressed will let you jump through the preset list in steps of 5 presets. Once a new preset location is found depress STORE again. The STORE LED goes out. The preset is stored at the new location.

In case you want to quit the STORE mode without storing the new adjustments simply press APPLY.

Storing a preset:

Depress STORE for1 sec.,
LED flashes;
use UP/DOWN to select preset no.;
depress STORE again,
LED goes out, preset is stored

If you want to apply various presets depress APPLY for one second. The APPLY LED starts to flash indicating that the APPLY mode is activated. You can step through the preset list with UP and DOWN. Once you have a preset that you want to apply depress APPLY again. The APPLY LED goes out indicating that the preset is applied.

In case you want to quit the APPLY mode without applying the new preset simply press STORE.

Applying a preset:

Depress APPLY for1 sec.,
LED flashes;
use UP/DOWN to select preset no.;
depress APPLY again,
LED goes out, preset is applied

NOTE: To increase operation safety it is impossible to apply presets by simply depressing UP or DOWN. The UP and DOWN status-LEDs will not flash indicating that the input is not accepted. You have to depress STORE or APPLY for one second in order to activate the UP and DOWN buttons.

Operation safety:
Presets can not be changed by accident

Info

10

Depressing STORE and APPLY simultanously for about one second gets you into a hardware dialogue, called INFO. The LC-display shows status informations of the digital data stream. With UP/DOWN you will jump from one page to the next or previous. If a selection is provided use APPLY to select.

1. Software version and date

Software Version
1.0 03/1997

2. Selecting inputs:

The MACHINE HEAD automatically searches for an input signal. If both inputs are connected the AES/EBU input will be selected first. If you want to select the S/P-DIF input you have to call up the INFO pages.

IMPORTANT: When selecting a new input allow the SIG.-LEDs to go out before stepping to the next input format. Otherwise MACHINE HEAD may lose the data stream.

Input Format
AES/EBU

AES/EBU input detected

or:

Input Format
no AES/EBU

no AES/EBU input detected.

Press APPLY (if AES/EBU is detected):

Input Format
AES/EBU WC

AES/EBU input with wordclock detected

or:

Input Format
no AES/EBU WC

AES/EBU input without worddlock detected

Press APPLY :

Input Format
S/P-DIF

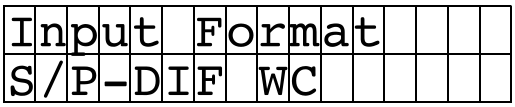
S/P-DIF-Eingang detected

or:

Input Format
no S/P-DIF

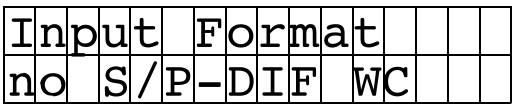
no S/P-DIF input detected

Press APPLY (if S/P-DIF is detected):



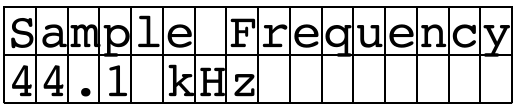
S/P-DIF with wordclock detected

or:



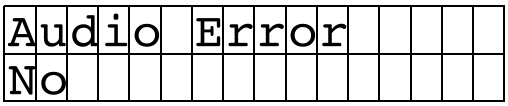
S/P-DIF input without wordclock is detected

3. Displaying the detected sample frequency:



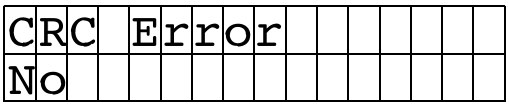
The SAMPLE FREQUENCY will be detected automatically.
The display either shows 44,1 kHz, 48 kHz or 32 kHz.

4. Displaying the Audio-Error flag:



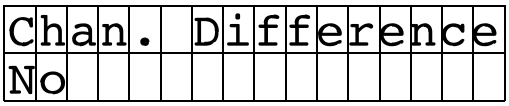
NO = no error detected; YES = error detected

5. Displaying the CRC-Error flag:



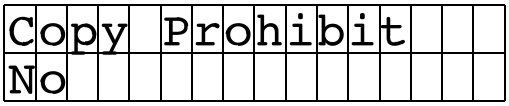
NO = no error detected; YES = error detected

6. Displaying the Channel Difference Error flag:



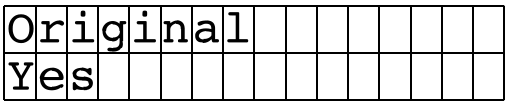
NO = no error detected; YES = error detected

7. Setting or erasing the Copy-Prohibit flag:



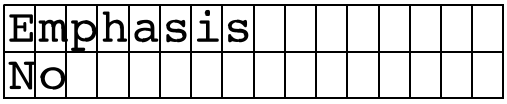
NO = flag erased or not set; YES = flag set

8. Displaying the Original flag:



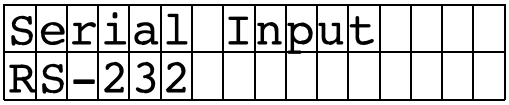
NO = no original; YES = original

9. **Displaying the Emphasis flag:**



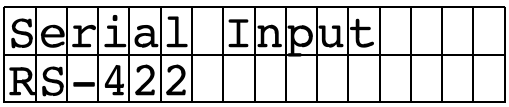
NO = no emphasis; YES = with emphasis

10. **Selecting a serial port:**



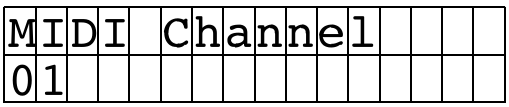
RS-232 interface for update-download from PCs

or (press APPLY):



RS-422 interface for update-download from MACs.

11. **Selecting a MIDI channel:**



Depress APPLY to step from MIDI CHANNEL 01 up to MIDI CHANNEL 16.

In order to increase operation safety only send the necessary MIDI data to the MACHINE HEAD. Unnecessary information may lead to system failure.

You can use MIDI to create a MIDI fade out, if you are working with a digital console that does not provide master inserts. The UP and DOWN LEDS illuminate indicating that a volume change command is received.

You can also switch between presets with the MIDI program change command. This can especially be useful, when you are mastering a song, for example, that requires different settings for chorus, refrain, or bridge. The APPLY LED illuminates indicating that a program change command is received.

MIDI IMPLEMENTATIONS

	Function	Received Data	Note
Basic Channel:	Change	1-16	stored
Control Change:	7	1-127	Volume
Program Change:		0-99	real value

Software Version 1.0 12/1996

You leave the INFO pages by depressing STORE.

Input/Output

Sample rate frequency, autom.	32-48kHz
AES/EBU, twisted pair (1)	AES 3
AES/EBU in- & output impedance	110 Ohms
S/P-DIF, co-axial (2)	SPDIF-2
S/P-DIF input impedance	75 Ohms
Wordclock In/Through, co-axial	BNC
Wordclock in-/output impedance	75 Ohms
MIDI In/Through	yes
RS 232	yes
RS 422 (max +/- 14V)	yes
Clip display	yes
Input transformer (AES/EBU)	yes
Output transformer (AES/EBU)	yes
Relay Hard Bypass (AES/EBU)	yes

Measurements

AES/EBU: Jitter	1ns
S/P-DIF: Jitter	3ns
Wordclock In: Jitter	1,5ns

Power supply

Torroidal transformer	60 VA
Fuse	1,6 A/slow blow
GND-Lift switch	yes
Voltage selector	115V/230V

Dimensions

Housing	19"/1U; 482 x 44,45 x 350mm
Weight	4,9 kg

(1) AES/EBU is defined for levels from 2 V to 7 V
Measurements AES/EBU: 4,4 V with load
(2) S/P-DIF is defined for levels from 200 mV to 700 mV
Measurements S/P-DIF: 500 mV with load

Subject to change without notice.

Warranty

SPL electronics GmbH (hereafter called SPL) products are warranted only in the country where purchased, through the authorized SPL distributor in that country, against defects in material or workmanship. The specific period of this limited warranty shall be that which is described to the original retail purchaser by the authorized SPL dealer or distributor at the time of purchase.

SPL does not, however, warrant its products against any and all defects:

1) arising out of materials or workmanship not provided or furnished by SPL, or 2) resulting from abnormal use of the product or use in violation of instructions, or 3) in products repaired or serviced by other than authorized SPL repair facilities, or 4) in products with removed or defaced serial numbers, or 5) in components or parts or products expressly warranted by another manufacturer.

SPL agrees, through the applicable authorized distributor, to repair or replace defects covered by this limited warranty with parts or products of original or improved design, at its option in each respect, if the defective product is shipped prior to the end of the warranty period to the designated authorized SPL warranty repair facility in the country where purchased, or to the SPL factory in Germany, in the original packaging or a replacement supplied by SPL, with all transportation costs and full insurance paid each way by the purchaser or owner.

All remedies and the measure of damages are limited to the above services. It is possible that economic loss or injury to person or property may result from the failure of the product; however, even if SPL has been advised of this possibility, this limited warranty does not cover any such consequential or incidental damages. Some states or countries do not allow the limitations or exclusion of incidental or consequential damages, so the above limitation may not apply to you.

Any and all warranties, express or implied, arising by law, course of dealing, course of performance, usage of trade, or otherwise, including but not limited to implied warranties of merchantability and fitness for particular, are limited to a period of 1 (one) year from either the date of manufacture. Some states or countries do not allow limitations on how long an implied warranty lasts, so the above limitations may not apply to you.

This limited warranty gives you specific legal rights, and you may also have other rights which vary from state to state, country to country.

SPL electronics GmbH

41372 Niederkrüchten, Germany